7.—Pyroxenic Granites and Related Rocks in the Jerramungup-Calyerup Creek Area, Western Australia

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The coarse porphyritic pyroxenic Jerramungup Adamellite makes a sharp contact with unusual hypersthene granulites at Calyerup Creek. Not far from this contact large angular blocks of Jerramungup Adamellite occur as xenoliths in the even-grained biotitic Calyerup Granodiorite. A chemical analysis and some petrological data of rock types at Calyerup Creek are recorded and comparisons are drawn with the porphyritic pyroxene adamellite from the type area at Jerramungup. Monazite, fluorite and anatase occur in the Calyerup Granodiorite. Clinopyroxene, hornblende and biotite are the femic minerals in the Jerramungup Adamellite at Calyerup Creek, but hypersthene occurs in addition in the type area about 5½ miles to the N.W. The mineralogy of the basic clots in the porphyritic adamellite suggests that they are much-modified micro-xenoliths derived from metasomatized country-rocks not known in the area. The Jerramungup Adamellite and Calyerup Granodiorite are formally named.

Introduction

A narrow belt of about 1,000 feet of clean outcrop in the Calyerup Creek was mapped and a brief reconnaissance of the neighbourhood undertaken in January, 1950.

The purpose of this paper is to record some of the evidence for the magmatic emplacement of the Calyerup Granodiorite and some unusual mineralogical and petrological features of this and some associated rocks.

Calycrup Creek is a non-perennial saline watercourse which joins the Gairdner River about 5½ miles south of Jerramungup homestead which is about 280 miles by road S.E. of Perth and 27 miles E. of Ongerup on the Ongerup-Ravensthorpe road. The outcrops described in this paper occur where (in January, 1950) the Quaalup-Jerramungup track crossed the creek known as Calyerup Creek 7 miles S.E. of Jerramungup (measured along the track). There are many good outcrops in the neighbourhood, especially in the valley of the Gairdner River.

Mineral Compositions

The following graphs were used:—plagioclase—Winchell and Winchell (1951, p. 283, Fig. 176), orthopyroxene—Poldervaart (1950, p. 1076, Fig. 3), clinopyroxene—Hess (1949, p. 634, Plate 1).

Terminology

"Magma" is used of a mass which has moved into its present position, either wholly liquid or as a mobile crystal mush. *Adamellite* and *granodiorite* are used as in Hatch, *et al.* (1949).

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Structure

The map (Fig. 1) clearly shows that the even-grained biotitic Calyerup Granodiorite has been emplaced magmatically into the coarse porphyritic pyroxenic Jerramungup Adamellite. There has been no obvious macroscopic corrosion of the xenoliths of Jerramungup Adamellite by the Calyerup Granodiorite, but basic xenoliths show considerable signs of assimilation (e.g., 31291, † p. 37). The foliation due to flowage of smaller lenticular basic xenoliths is obvious near the large angular xenoliths of Jerramungup Adamellite. Elsewhere the Calyerup Granodiorite is fairly homogeneous, even-grained and massive.

The varying trend of foliation from block to block of the angular xenoliths of Jerramungup Adamellite demonstrates movement of the blocks. It should be remembered, however, that such movement could have taken place at the time of brecciation of the adamellite and not necessarily at the time of active injection. The strong streaming foliation in the younger granite near the xenoliths suggests, however, that the brecciation, rotation of the blocks, and injection were pene-contemporaneous. The evidence from the small area which was mapped suggests that the brecciation was controlled by N.-S. subhorizontal shear (W. block N.) and granite injection was controlled by much reduced stresses acting in a similar sense.

Sharp contacts of the coarse porphyritic Jerramungup Adamellite and a somewhat migmatized hypersthene-biotite-andesine granulite were noted less than 100 yards upstream from the eastern edge of the map. Although there was no time to make a detailed study of the contact, it would appear that the development of some of the features of the granulite was due to the emplacement of the Calyerup Granodiorite (see p. 36). It is hoped that these notes will encourage a detailed study of the good outcrops of metamorphic rocks in Calyerup Creek.

Petrology

Meta-sediments

Hypersthene-quartz-biotite-andesine granulite (31289).—Greywackes have been strongly metamorphosed to form a coarse hornfels or granulite near the contact with porphyritic pyroxenic adamellite (31288).

† Numbers refer to specimens housed in the Department of Geology, University of Western Australia.

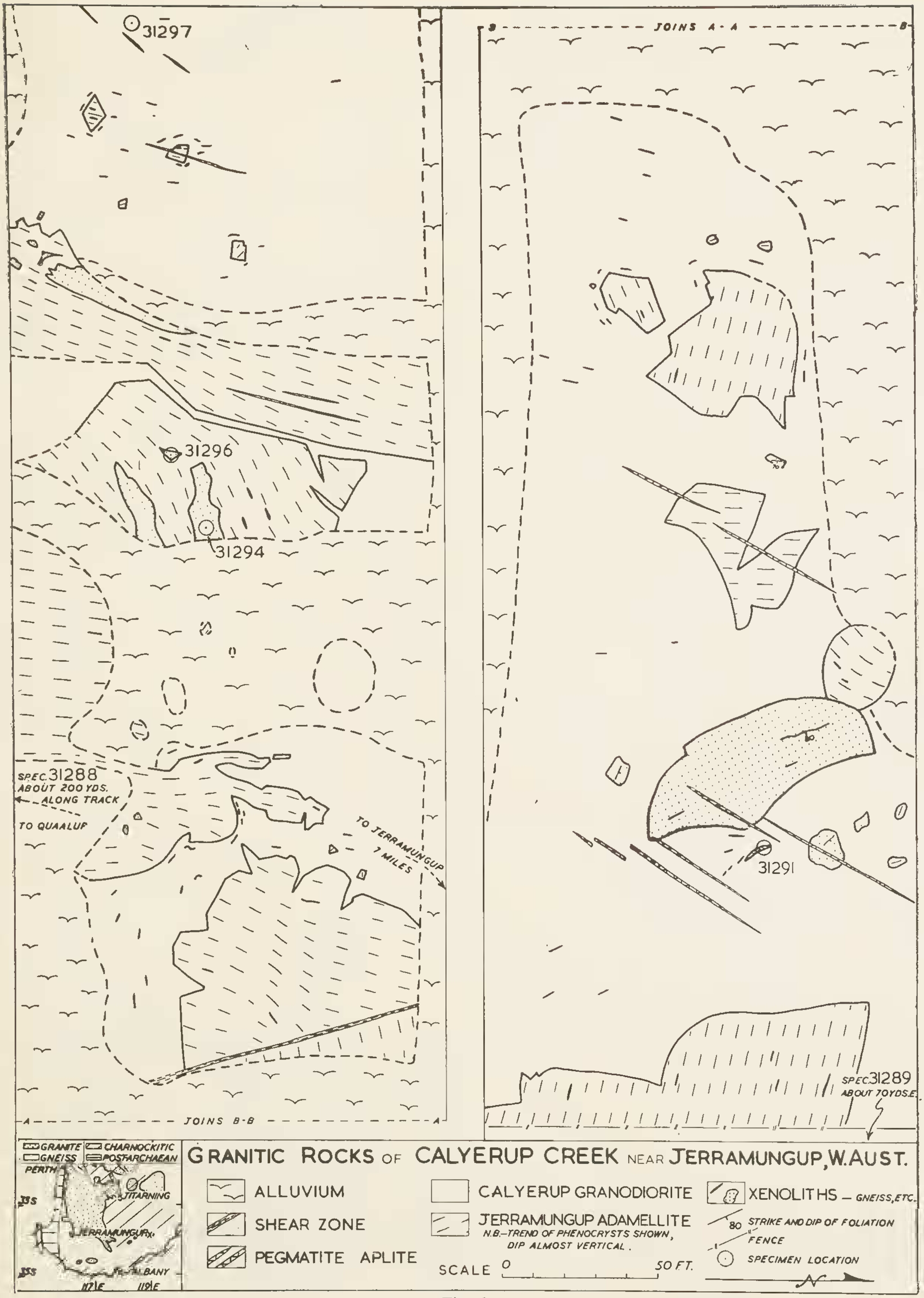
31297
31296
31294
JOINS A-A
B
B
SPEC. 31288
ABOUT 200 YDS.
ALONG TRACK
TO QUAALUP
TO JERRAMUNGUP
7 MILES
31291
SPEC. 31289
ABOUT 70 YDS. E.
A
A
JOINS B-B
GRANITE
CHARNOCKITIC
GNEISS
POSTARCHAEAN
PERTH
TITARNING
33S
JERRAMUNGUP
ALBANY
35S
117E
119E
GRANITIC ROCKS OF CALYERUP CREEK NEAR JERRAMUNGUP, W. AUST.
ALLUVIUM
SHEAR ZONE
PEGMATITE APLITE
CALYERUP GRANODIORITE
JERRAMUNGUP ADAMELLITE
N.B.—TREND OF PHENOCRYSTS SHOWN, DIP ALMOST VERTICAL.
SCALE 0 50 FT.
XENOLITHS — GNEISS, ETC.
80
STRIKE AND DIP OF FOLIATION
FENCE
SPECIMEN LOCATION
N

Fig. 1.

Specimen 31289 is a dark grey, fine to medium-grained, dense rock in which poor original bedding planes are not readily recognised except in thin-section. The rock is fairly homogeneous except where cut by occasional narrow migmatitic veins. The micro-texture is banded granulose with a rude orientation of biotite parallel to the bedding. Most minerals are between 0.25 mm and 0.3 mm in diameter. The main minerals are as follow:—

Andesine (about 50%): anhedral and equidimensional; albite and pericline twins; extinction $\perp a$, $\alpha' \wedge (010) = +21°$ indicating An_{38}.

Biotite (about 20%): pleochroism, α = straw yellow, γ = reddish brown, with prominent pleochroic haloes; sensibly uniaxial (-ve.); β = 1.642 ± .003.

Quartz (about 15%): anhedral and equidimensional non-strained grains.

Hypersthene (about 15%): anhedral equidimensional grains; strongly pleochroic with α = pink, β = pale fawn, γ = pale green; $2V\alpha$ = 60° ± 2°; γ = 1.707 ± .003, indicating about Of_{32}.

Zircon and *monazite* occur as small anhedral grains, commonly as cores of pleochroic haloes in biotite, and *pyrite* and *apatite* are uncommon accessories.

In a small acidic vein which cuts the rock the following minerals are developed:—

Quartz, andesine, cordierite (showing pleochroic haloes and some pinitization), *biotite* and rare large *hypersthene* grains.

The biotite and hypersthene both occur in large grains and are of the same type as in the main rock where they appear to be stable together. In the vein the cordierite appears to be stable with both hypersthene and biotite. Cordierite has not been found in any other rock of the area. It is the apparent stability of cordierite and hypersthene (with biotite) that would suggest that this rock belongs to the pyroxene-hornfels metamorphic facies rather than to the granulite metamorphic facies. The proximity of two intrusions has caused great complications and a proper metamorphic study must await more detailed mapping and sampling. However, since the biotites of both the country-rock and the Calyerup Granodiorite are very similar in all respects it would appear that the formation of biotite and the development in the vein of the cordierite and coarse hypersthene were controlled by the emplacement of the Calyerup Granodiorite and not by the porphyritic pyroxene adamellite.

The granitic rocks at Calyerup Creek

Coarse porphyritic hornblende-salite-biotite adamellite (a facies of the Jerramungup Adamellite)—(31288).—This specimen (31288) was collected 20 yards N.W. of the gate approximately 250 yards S.S.E. from Calyerup Creek crossing on the Jerramungup-Quaalup track, and was selected as typical of the Jerramungup Adamellite in the Calyerup Creek area. It is coarse-grained, light grey, granitic rock with about 20% of subhedral phenocrysts of pink microcline which are set in a matrix mainly of white plagioclase and femic minerals. Although platy-flow structure is not pronounced it is measurable.

In thin-section the texture is typically granitic with average diameter of matrix femic minerals about 1 mm and matrix felsic minerals about 2 mm. Some of the more significant characteristics of the minerals are as follow:—

Microcline (about 30% of rock): Phenocrysts (mostly 3 cm long) make up about 20% of the rock; commonly twinned (Carlsbad); a pale pink fluorescence is exhibited under short-wave ultra-violet radiation (cf. Wilson 1950); similar microcline (about 10% of rock) is in the matrix where it corrodes plagioclase and forms ragged micro-antiperthite.

Oligoclase (about 35% of the rock): confined to the matrix where commonly it is heavily corroded by microcline, resulting in ragged and irregularly distributed micro-antiperthitic inclusions; extinction $\perp a$, $\alpha' \wedge (010) = +3°$, indicating An_{22}; some myrmekitic growths on edges of grains.

Quartz (about 19% of the rock): undulose extinction.

Biotite (about 10% of the rock): pleochroism, α = brownish yellow, γ = dark brown; sensibly uniaxial (-ve.); β = 1.651 ± .002; appears to be corroded by hornblende; shows alteration to *chlorite* and *sphene* in places.

Clinopyroxene (2.6%): important constituent of basic clots; pale green and almost non-pleochroic; β = 1.697 ± .001; $2V\gamma$ = 56° ± 2°; composition is approximately $Wo_{47}\ En_{34}\ Fs_{19}$, indicating a *salite*.

Amphibole (2.4%): large poikilitic grains (up to 4 mm long) enclosing biotite, clinopyroxene, apatite, and magnetite; pleochroism, α = yellowish fawn, β = khaki-green, γ = deep green; γ = 1.686 ± .002; $2V\alpha$ = 55° (approx.).

The accessories make up about 1% of the rock. The most important are *fluor-apatite* (which is abundant as subhedral grains in the femic clots), *sphene* (mostly as sparse ragged fawn-coloured growths in chloritized biotite, and rarely as a narrow rim around ilmenite), *zircon* (murky pinkish brown, euhedral crystals which are non-fluorescent under short-wave ultra-violet radiation), *ilmenite* and *magnetite*, rare meta-mict (?) allanite and very rare *monazite*.

There is abundant evidence that the plagioclase and quartz have been shattered, impregnated and partly replaced by microcline. The femic clots may represent reconstituted microxenoliths of the country-rocks, but it should be observed that, as far as is known, the biotite and pyroxene of the immediately adjacent country-rocks have no resemblance to the biotite and pyroxene of the adamellites.

Xenoliths in the coarse porphyritic adamellite.—Many lenticular and partly assimilated xenoliths are common in both the coarse porphyritic adamellite and the even-grained Calyerup Granodiorite. It is not intended to present detailed descriptions of the xenoliths, but some of the more important petrological features of two of them are outlined immediately below.

(i) *Hypersthene-biotite-oligoclase-microcline-quartz granulite (31294).*—This faintly banded fawn-brown rock shows an orientation of much-chloritized hypersthene and biotite. There are irregular poikiloblasts of clinopyroxene and hornblende enclosing the other minerals which are commonly 0.3 mm in diameter. The quartz shows undulose extinction. The plagioclase is poorly twinned and the microcline is not markedly micro-perthitic. The biotite and hornblende resemble those of the host-adamellite.

(ii) *Salite-biotite-microcline-quartz-oligoclase granulite (31296).*—This greyish-fawn rock, with an average grain-size of 0.4 mm diameter, shows an orientation of the biotite (pleochroic, α = fawn, γ = dark brown). The clinopyroxene (and, to a less extent, hornblende) occurs as large irregular poikiloblastic masses. The biotite, clinopyroxene and hornblende are almost identical with those of the host-adamellite.

The orientated hypersthene grains in 31294 suggest that these granulites belong to the granulite metamorphic facies. The absence (as far as can be determined by study of crushings of the rock) of orthopyroxene from the porphyritic adamellite is notable in that orthopyroxene is found in the country-rock (e.g., 31289) and in many xenoliths. The growth (as poikiloblasts) of clinopyroxene and hornblende of types so similar chemically to those of the host-adamellite indicates that the rock as a xenolith must have reached a grade of metamorphism equivalent to a high level of the amphibolite facies.

Biotite granodiorite (the Calyerup Granodiorite)—(31297).—This specimen, which was collected approximately 250 feet downstream from the Calyerup Creek crossing, is to be considered the type-specimen of the homogeneous granodiorite which intrudes the Jerramungup Adamellite and other rocks of the area. The trend of flow-structure is only measurable with confidence where the occasional lenticular xenoliths of biotite schist occur. The trend is approximately a few degrees E. of N. The Calyerup Granodiorite is thought to be of Precambrian age. The rock is mostly even-grained with grains about 1.8 mm in diameter, but there are a few phenocrysts of microcline up to 10 mm in length.

In thin-section the texture is typically granitic. Some of the more significant characteristics of the minerals are as follow:—

Oligoclase (40.7%): extinction $\perp a$, $\alpha' \wedge (010) = +7\frac{1}{2}°$ (with negligible zoning) indicating An_{25}; ragged and irregularly distributed micro-antiperthitic inclusions of microcline; albite twinning and pericline twinning.

Quartz (28.0%): undulose extinction.

Microcline (18.5%): fresh (less kaolinized than plagioclase which it commonly corrodes); almost negligible micro-perthitc; cross-hatch twinning.

Biotite (11.6%): pleochroism, α = light yellowish fawn, β = dark orange-brown, γ = very dark brown; sensibly uniaxial (-ve.); β = 1.649 ± .002; some *chloritization* (chlorite: length slow; β = 1.626 but variable); prominent pleochroic haloes around monazite and zircon; apparently random orientation of grains.

Fluor-apatite (0.4%): colourless and non-fluorescent (short wave U.V.); euhedral and subhedral grains; small cores of darker (?) apatite not rare.

Iron ores (0.5%): mostly concentrated in the femic clots; *magnetite, ilmenite* (commonly leucoxenized) and *pyrite* (which may be surrounded by magnetite or *haematite*).

Monazite (0.1%): resinous yellow; rounded, and some grains have a thin alteration crust; 2V γ approximately 10°; identity confirmed by spectroscope (Wilson 1958*b*).

Zircon: small, colourless, euhedral crystals up to 0.15 mm long; elongate bubble- and mineral-inclusions common; zoned; some radioactive as shown by some of the haloes in biotite; fluorescence nil (short-wave U.V.).

Fluorite: uneven blue grains found only in rock-crushings.

Anatase: (P. E. Playford, who made some preliminary observations on this specimen, was the first to discover the anatase) orange-brown, highly refringent and strongly doubly refracting, slightly pleochroic, minute euhedral prismatic crystals in (and apparently restricted to) chlorite which is formed by alteration of ilmenite and biotite.

Calcite, epidote, (?) allanite, muscovite, and *lawsonite* are very rare accessories. Orthopyroxene and amphibole are absent.

Plagioclase, most of the quartz and possibly some of the biotite would appear to have formed prior to emplacement of the granodiorite. Microcline, and some quartz and biotite have corroded and "healed" the strained crystal mush, and volatile-rich material and hot waters at a late stage have produced much of the monazite, chlorite, anatase, fluorite, calcite, lawsonite and haematite.

An *analysis* of this rock appears in Table I as No. 5. The analysis, norm and mode show that this rock is actually between granodiorite and adamellite in composition. There is no obvious chemical similarity between this rock and the Jerramungup Adamellite.

Xenolith in the Calyerup Granodiorite (31291).—This is a very dark grey coarse very basic hornfels composed of hornblende, hypersthene, clinopyroxene, biotite and quartz. The hornblende poikiloblasts include both pyroxenes and there is a tendency for the biotite to show a preferred orientation. The biotite is similar in colour and type to the biotite of the hypersthene-quartz-biotite-andesine granulite of the country-rock (see p. 36) but is much different from the biotite of the porphyritic pyroxene adamellite. The growth of the biotite and possibly the cordierite and coarse hypersthene in the country-rock thus may be due to metamorphism by the granodiorite and not by the adamellite.

The granitic rocks at Jerramungup

Coarse porphyritic hypersthene-biotite-salite-adamellite (the Jerramungup Adamellite)—(31303).—A brief description of this rock, collected by the author from an excellent exposure in the Gairdner river close to the old Jerramungup homestead, was included by Prider in an earlier paper (Clarke, *et al.* 1954, p. 45). A chemical analysis and more mineralogical data are now available, but Threadgold's excellent modal analysis is retained. The analysis of this rock appears in Table I as No. 1.

Specimen 31303 is a coarse porphyritic rock containing 35% (by volume) of pink euhedral microcline phenocrysts (up to 4 cm long) in a mesocratic coarse matrix of white oligoclase, dull green pyroxene, brown biotite, colourless quartz and pink microcline. The phenocrysts fluoresce a rose-pink under short-wave ultraviolet radiation (cf. 31288 from Calyerup Creek, and see also Wilson 1950). In outcrop the phenocrysts are alined with strike approximately 340° (but strike is variable in the area) and dip 75° W. Numerous narrow micro-granitic dykes trending roughly E.N.E. cut the adamellite, and thin-section study shows that the microcline phenocrysts commonly enclose large irregular relics of oligoclase, clots of clinopyroxene, orthopyroxene, magnetite, biotite and quartz. The phenocrysts, therefore, are not the first crystals to form in the mass which later became the "magma." The author suspects the phenocrysts grew in the matrix (at the time either solid, or a crystal mush) during the early stage of the emplacement of the "magma." In any case, they were soon in a relatively fluid mass, and sufficiently well-formed to resist deformation (but contrast the deformed grains of plagioclase), yet platy-flow structure was able to develop. Indeed, it would seem that during phases of the emplacement many variable rock types could be formed either by solidification of potassic material removed from time to time by filter-press action, or by solidification of the residues at various places and times. It is thought significant that numerous narrow micro-granitic dykes (trending roughly E.N.E., i.e., normal to the regional flow-alinement of the phenocrysts) cut the adamellite near the Jerramungup homestead. For several years, the author has thought that a filter-press mechanism may be responsible for a comparable association of porphyritic granites and micro-granitic rocks in the Dale Bridge area near York (Wilson 1952, pp. 216-217, and 1958*a*). The Jerramungup Adamellite is thought to be of Precambrian age.

Some of the main petrographic data for the rock are as follow:—

The phenocrysts of microcline (35% of the rock) are up to 4 cm long, plagioclase is commonly 6 mm long and individual grains of femic minerals and quartz are mostly somewhat more than 1 mm long.

Oligoclase (40.3% of rock, 60.7% of matrix): mostly confined to the matrix where it is commonly much corroded by microcline or impregnated by microcline to give ragged and irregularly distributed micro-antiperthitic inclusions, but there are numerous relics within the microcline phenocrysts; extinction $\perp a$, $\alpha' \wedge (010) = +5\frac{1}{2}°$ for some relics in microcline phenocrysts and it ranges from $+3°$ to $+7°$ elsewhere in the matrix, thus indicating a variation in apparently unzoned grains from An_{22} to An_{26}; chloritization and saussuritization have developed along some albite twin-planes adjacent to serpentinized hypersthene; may be separated from corroding microcline by myrmekite.

Microcline (38.0% of rock, 6.7% of matrix): large phenocrysts up to 4 cm long, small irregular grains in the matrix and micro-antiperthitic inclusions in oligoclase; severely replaces oligoclase (q.v.); weakly microperthitic.

Clinopyroxene (7.3% of rock, 11.0% of matrix): pale green almost non-pleochroic; $\beta = 1.697 \pm .001$; $2V\gamma = 54\frac{1}{2}° \pm 1°$; composition is approximately $Wo_{45}\ En_{35}\ Fs_{20}$, indicating a *salite;* a major constituent of the femic clots, and commonly rims orthopyroxene which is less stable to hydrothermal activity and is heavily serpentinized.

Quartz (5.6% of rock, 8.5% of matrix): majority of grains show undulose extinction but some associated with symplectic growths of biotite are unstrained.

Biotite (5.6% or rock, 8.5% of matrix): pleochroism, α = straw-yellow, γ = red-brown, and with pleochroic haloes around zircon and small grains of (?) monazite; sensibly uniaxial (-ve.); $\beta = 1.640 \pm .002$; mostly associated with clinopyroxene but may be found in symplectic intergrowth with unstrained quartz.

Orthopyroxene (1.4% of rock, 2.1% of matrix): occurs in femic clots as relict patches included in fibrous chloritic masses impregnated with magnetite dust; pleochroism weak, α = very pale reddish brown, γ = very pale green; $2V\alpha = 54\frac{1}{2}° \pm 1\frac{1}{2}°$ ($55° - 55\frac{1}{2}°$, uncorrected for hemispheres with $n = 1.649$) indicating hypersthene about Of_{37}; R.I. (γ) difficult to measure because of alteration products, but with $\gamma = 1.695$ (approx.) the mineral would seem to be bronzite (note: for $\gamma = 1.695$, 2V should be about 70° not $54\frac{1}{2}°$ as determined); consequently, the composition is in doubt, but *hypersthene* (say, about Of_{35}) is favoured.

Iron ores (1.3% of rock, 2.0% of matrix): mostly in form of irregular grains of magnetite in the femic clots; secondary magnetite dust is common with the altered hypersthene.

Other accessories (0.5% of rock) are *fluorapatite* (plentiful as subhedral grains in the femic clots), *zircon* (radioactive nuclei of haloes in biotite; mostly murky fawn-coloured subhedral grains; strongly zoned with cores of darker granules of zircon, or opaque granules), *hornblende* and *monazite*.

The source of the basic clots and xenoliths, both of which may contain orthopyroxene and clinopyroxene, is uncertain. No geological mapping of the area has been done, but the nearest outcrop of pyroxene-bearing metamorphic country-rocks (so far as is known) is near Calyerup Creek some 5½ miles S.E., but at the contact the coarse porphyritic adamellite (31288) is both devoid of orthopyroxene and more siliceous.

Although it is suspected that the orthopyroxene (and clinopyroxene) of these adamellites is related to charnockitic rocks in the vicinity (see Wilson 1958*a*: map), it should be pointed out that the orthopyroxene of similar Central Australian "igneous rocks" (which from most of the evidence seem to have a similar palingenetic origin) is significantly different from the orthopyroxene of the country rocks. In Central Australia, where there was less difficulty in establishing the compositions of the pyroxenes, these phenomena were carefully documented (Wilson 1954*a*, p. 15, but especially 1954*b*, pp. 173-180). There would appear to be a fundamental reconstitution of the pyroxenes (and some other minerals) during mobilization of the country-rocks. In the Jerramungup area, however, there is as yet no evidence of the ferriferous orthopyroxenes which seem to appear in most pyroxenic "granites."

The physico-chemical condition which presumably would allow the country-rocks to become mobilized may be expected to be different (e.g., in content of H_2O, O, F, P, etc.) from those prevailing in the country-rocks, even though temperature and pressure may be sufficiently high to allow the formation of mineral assemblages which are comparable to those of the granulite metamorphic facies.

The name, Jerramungup Adamellite, is formally given to the pyroxenic rock described above. By some strict definitions the rock could be called a monzonite, for the analysis (Table I) shows less than 65% SiO_2, and both normative and modal quartz are less than 10%. However, an over-all average composition of the porphyritic "granite" of the whole Jerramungup area appears to be that of a typical adamellite (as seen, for instance, at Calyerup Creek where 19% quartz occurs in 31288).

The analysis, norm and mode of the porphyritic Jerramungup Adamellite (Table I, No. 1) are set out for comparison with those of other porphyritic granites, viz., the Everard Adamellite from Central Australia (No. 2), the Albany Adamellite from the south-coastal regions of Western Australia (No. 3) and a typical granite from the Wheat Belt region of Western Australia, the porphyritic adamellite from near Jitarning (No. 4). A more detailed review of the composition of Western Australian granites is being published elsewhere (Wilson 1958*a*).

TABLE I

Granites from Calyerup and Jerramungup

	1	2	3	4	5
SiO_2	62·08	65·17	66·90	64·76	65·54
TiO_2	0·54	0·56	0·63	0·97	0·58
Al_2O_3	15·94	17·34	14·76	13·99	15·78
Fe_2O_3	0·76	1·60	0·32	2·07	1·02
FeO	3·56	2·09	5·01	3·52	3·90
MnO	0·08	0·18	0·12	0·27	tr.
MgO	2·88	0·49	0·93	1·41	1·92
CaO	4·32	3·35	2·46	3·86	2·63
BaO	...	0·19		0·12	
Na_2O	3·56	3·48	2·42	3·42	3·33
K_2O	5·12	5·43	5·04	3·46	3·62
H_2O+	0·58	0·10	0·93	0·59	1·02
H_2O-	*nil*	0·05	0·08	0·03	0·09
P_2O_5	0·51	0·23	0·21	0·47	0·17
CO_2	*nil*		*nil*	0·16	0·20
	99·93	100·26	99·81	99·89*	99·80
			C. I. P. W. Norms		
qtz.	8·50	15·93	23·88	21·48	22·37
o'clase	30·23	32·08	29·47	20·43	21·34
albite	30·11	29·34	20·44	28·96	28·17
anorth.	12·38	15·54	11·40	13·13	10·79
corund.		0·04	1·22		2·44
diop. wo	2·50	....	....	2·65	
diop. en	1·40	...	...		
diop. fs	1·00				
hyp. en	5·77	1·20	2·30	5·86	4·78
hyp. of	4·14	1·91	7·92		5·36
mag.	1·11	2·32	0·46	2·99	1·48
ilmen.	1·03	1·06	1·22	1·83	1·11
apat.	1·21	0·54	0·34	1·11	0·40
pyrite	.		. .	0·49 calc.	— 0·45
			Modes (Volume %)		
qtz.	5·6	17	K-fel.	olig.	28·0
K-fel.	38·0	35	andes.	qtz.	18·5
plag.	40·3	39	qtz.	K-fel.	40·7
o'pyr.	1·4	—	biot.	biot.	—
c'pyr.	7·3	1	horn.	horn.	—
amphib.	tr.	4	ores	ilmen.	—
biot.	5·6	0·5	sphene	epid.	11·6
ores	1·3	3	calc.	apat.	0·5
apat.	0·3	0·5	apat.	zois.	0·4
S.G.	2·785†	2·685†	2·701†	2·77	2·694†

1. Porphyritic pyroxene adamellite (the Jerramungup Adamellite) (31303), Jerramungup, W. Aust. Anal., W. H. Herdsman.
2. Porphyritic hornblende adamellite (the Everard Adamellite) (30265), Umgulbullarinna Rock Hole, Everard Ranges, C. Aust. (Wilson 1954*b*, p. 119).
3. Porphyritic adamellite (the Albany Adamellite) (30974), Mt. Melville, Albany, W. Aust. (Clarke, *et al.* 1954, p. 43).
4. Porphyritic adamellite, Res. 12096, 86 mile peg No. 2 Rabbit Proof Fence, near Jitarning, W. Aust. Anal., H. P. Rowledge.
5. Biotite granodiorite (the Calyerup Granodiorite) (31297), Calyerup Creek, near Jerramungup, W. Aust. Anal., W. H. Herdsman.

* Includes FeS_2 = 0.49, V_2O_3 = 0.30, ZrO_2 — tr, Cr_2O_3 — nil.

† S.G. accurate to ± 0.002.

Conclusions

Petrographic studies would suggest that the coarse porphyritic pyroxenic granites of the Jerramungup-Calyerup Creek area were formed by a reconstitution and feldspathization of basic rocks. In several parts of the area (e.g., Calyerup Creek) there are highly granitized xenoliths containing large porphyroblasts of microcline similar to the "phenocrysts" of the host rock. However, the gneisses and meta-sediments at the eastern contact contain no porphyroblasts. This suggests that the porphyritic granites may have been formed by a metasomatic process at a considerable depth. The Everard Adamellite from Central Australia is very similar in this respect.

The shattering of part of the Jerramungup Adamellite has allowed numerous granite and micrograntes to be emplaced. In the Calyerup Creek area the Calyerup Granodiorite (possibly a differentiate from the parent Jerramungup Adamellite "magma") may have been emplaced during or soon after the shattering and random jostling of the blocks of porphyritic adamellite.

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